REVISIONS

SYMBOL	DESCRIPTION	DATE	APPROVAL
E	• Updated Tables I and III to accurately reflect current product capabilities • Changed max. test temperature for RTC and Thermal Shock test to +110°C. Changed minimum Thermal Shock test temperature to –55°C • Changed responsible GSFC organization from Code 311 to Code 562 • Included the words "or equivalent" with the reference to MIL-I-45208. Clarified packaging requirement per MIL-R-39032 "or equivalent".	04/06/98	

SHEET REVISION STATUS

SH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
REV	E	E	E	E	E	E	E	E	E	E	E	E								
SH	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
REV																				

ORIGINATOR: T. Perry/Unisys	**DATE** 10/18/90	**FSC:** 5905
APPROVED: A. Garrison/Unisys	10/18/90	Resistor, Fixed, High Voltage (Victoreen Mini-Mox)
CODE 311 APPROVAL: F. Kreis/GSFC	10/19/90	
CODE 311 SUPERVISORY APPROVAL: D. Cleveland/GSFC	10/23/90	
ADDITIONAL APPROVAL:		**S-311-P-672**

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

CAGE CODE: 25306

1. SCOPE

1.1 Scope. This specification covers the procurement requirements for fixed, metal oxide, high voltage resistors. These resistors are intended for GSFC space system electronic circuits requiring high voltages and high resistance values with good stability.

1.2 Goddard part number. Parts procured in complete compliance with the requirements of this specification shall be identified by a Goddard part number of the following form.

G311P672	-1	-1003	F
Goddard Designator	Style (See 1.3)	Resistance Value (See 1.4)	Tolerance (See 1.5)

1.3 Style. The style shall be identified by a single number (1, 2 or 3) which specifies resistors of a type and size listed in Table I and Figure 1.

Table I. - Styles.

Style	Resistance Range (ohms)	Available Tolerances (%)	Power Rating (70°C)	Maximum Voltage Rating	Dimensions (inches)		Manufacturer	Manufacturer Type No.
					A (max)	B (max)		
1	500 - 1,000M	0.5	0.25W	1000V	0.540"	0.165"	Victoreen	MOX-400-23
	500 - 10,000M	1, 2						
	500 - 300,000M	5, 10						
2	1k - 10,000M	0.5	0.50W	2000V	0.860"	0.165"	Victoreen	MOX-750-23
	1k - 70,000M	1						
	1k - 100,000M	2						
	1k - 600,000M	5, 10						
3	1k - 10,000M	0.5	1.00W	5000V	1.250"	0.165"	Victoreen	MOX-1125-23
	1k - 100,000M	1, 2						
	1k - 400,000M	5						
	1k - 1,000,000M	10						

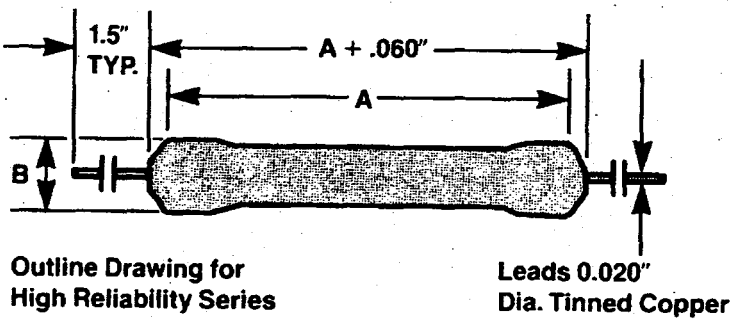

Figure 1. - Resistor outline drawing (ref. Table I).

1.4 Resistance value. The nominal resistance value is specified by four digits. The first three digits represent significant figures; the last digit specifies the number of zeroes to follow.

Example: 1003 = 100,000 ohm or 100k ohm

There are no standard resistance values.

1.5 Tolerance. The resistance tolerance is identified by a single letter in accordance with Table II.

Table II. - Resistance tolerance.

Letter	Resistance Tolerance
D	0.5%
F	1%
G	2%
J	5%
K	10%

1.6 Temperature characteristic. The resistance temperature characteristic is a function of the style and resistance value selected. The characteristic for temperature extremes of -55°C to +110°C, referenced at 25°C, may be determined from Table III (see 3.11).

Table III. - Temperature characteristic.

Resistance Temperature Characteristic (ref. 25°C)				
Style	Type	50 ppm/°C	100 ppm/°C	250 ppm/°C
1	MOX-400-23	500 - 450M	451M - 30,000M	30,100M - 300,000M
2	MOX-750-23	1k - 900M	901M - 70,000M	70,100M - 600,000M
3	MOX-1125-23	1k - 1,350M	1,360M - 100,000M	101,000M - 1,000,000M

1.7 Performance characteristics. The performance of resistors procured to this specification shall be as specified in Table IV.

Table IV. - Performance characteristics.

Test	Styles 1, 2, and 3
Thermal Shock (see 3.5)	ΔR ± 0.20%
Dielectric Withstanding Voltage (see 3.6)	ΔR ± 0.25%
Insulation Resistance (see 3.7)	10,000 MEG (min) dry
Overload (see 3.8)	ΔR ± 0.25%
Voltage Conditioning (see 3.9)	ΔR ± 0.20%
Full Load Stability (see 3.10)	ΔR ± 1.0%
Shock (see 3.12)	ΔR ± 0.25%
Vibration (see 3.13)	ΔR ± 0.25%
Terminal Strength (see 3.15)	ΔR ± 0.20%

2. APPLICABLE DOCUMENTS

2.1 Documents. The following documents, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

MIL-I-45208 Inspection Systems Requirements

MIL-R-39032 Resistors, Packaging of

STANDARDS

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts

MIL-STD-453 Radiographic Inspection

MIL-STD-1285 Marking of Electrical and Electronic Parts

2.1 Documents (Continued).

OTHER PUBLICATIONS

ASTM E595	Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment, Standard Test Method for
ASTM E801	Controlling Quality of Radiographic Testing of Electronic Devices, Standard Practice for

2.2 Order of precedence. In the event of any conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. However, nothing in this text shall supersede applicable laws and regulations unless a specific exemption has been obtained.

2.3 Copies of documents. Copies of federal and military documents can be obtained from the Standardization Document Order Desk, 700 Robbins Avenue, Building #4-Section D, Philadelphia, PA 19111-5094. Copies of ASTM publications are available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

3. REQUIREMENTS

3.1 Qualification. Resistors furnished to this specification shall be product which has been granted qualification approval by NASA/GSFC. Qualification approval shall be based on the following criteria.

3.1.1 Design and source approval. Prior to qualification, the manufacturer's facility shall be subjected to survey at the option of GSFC, by the Office of Flight Assurance, GSFC. Compliance with MIL-I-45208 or equivalent is required. In addition, the history and detailed engineering of the specific resistor design will be reviewed, as will the documented manufacturing and quality control procedures.

Only those sources approved in the design and source approval phase shall be eligible for qualification or award of contract under this specification. Source approval and design approval do not constitute part qualification or an equivalent thereof.

3.1.2 Part qualification. Resistor product granted qualification shall be that which has passed the qualification inspection requirement of this specification. This requirement may be satisfied by passing the qualification inspection (see 4.4).

3.2 Materials.

3.2.1 Materials. Materials shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the resistors to meet the performance requirement of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of finished product.

3.2.2 Thermal outgassing. Materials must meet outgassing requirements of 1.0% total mass loss (TML) and 0.1% collected volatile condensable materials (CVCM) when tested in accordance with 4.6.16.

3.3 Design and construction. Resistors shall be of the design, construction and dimensions depicted in Figure 1.

3.3.1 Terminal leads. Terminal leads shall consist of a solid copper conductor suitably treated to meet the solderability requirement (see 4.6.14).

3.3.2 Insulation. Resistors shall be coated with Dexter Hysol epoxy DK18-05 or equivalent.

3.3.3 Resistance material. The metal oxide shall be uniformly deposited and free of blisters, thin spots, discolorations or any other types of anomalies likely to cause flaking or a non-uniform ribbon when spiraled (helixed).

3.3.4 End caps. The misalignment of the cap with respect to the core shall not exceed 5 degrees.

3.3.5 Power rating. Power rating is based on continuous full load operation at a rated ambient temperature of 70°C as specified in Table I. For higher temperatures, derating shall be in accordance with Figure 2.

3.3.6 Voltage rating. Resistors shall have a rated direct current (dc) continuous working voltage, or an approximate sine wave root-mean-square (rms) continuous working voltage at commercial line frequency and waveform, corresponding to the power rating as determined from the following formula:

$$E = \sqrt{PR}$$

Where:

E = rated dc or rms continuous working voltage
P = power rating (see 3.3.5)
R = nominal resistance

In no case shall the rated dc or rms continuous working voltage exceed the value specified in Table I.

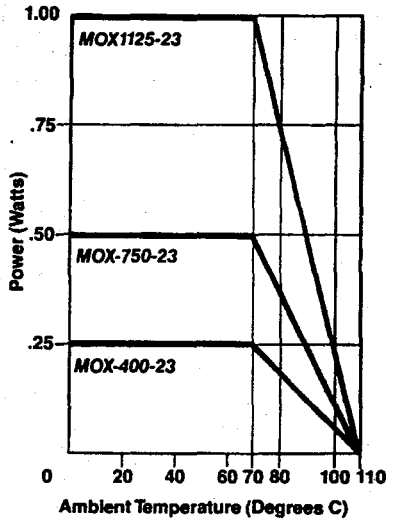

Figure 2. - Resistor derating.

3.4 DC resistance. When resistors are tested as specified in 4.6.2, the dc resistance shall be within the specified tolerance of the nominal resistance.

3.5 Thermal shock. When resistors are tested as specified in 4.6.3, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the requirement in Table IV.

3.6 Dielectric withstanding voltage. When resistors are tested as specified in 4.6.4, there shall be no evidence of flashover, arcing, insulation breakdown, or any type of mechanical damage. The change in resistance shall not exceed the requirement in Table IV.

3.7 Insulation resistance. When resistors are tested as specified in 4.6.5, the insulation resistance shall meet the requirement in Table IV.

3.8 Overload. When resistors are tested as specified in 4.6.6, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the requirement in Table IV.

3.9 Voltage conditioning. When resistors are tested as specified in 4.6.7, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the requirement in Table IV.

3.10 Full load stability. When resistors are tested as specified in 4.6.8, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the requirement in Table IV.

3.11 Resistance temperature characteristic. When resistors are tested as specified in 4.6.9, the resistance temperature characteristic between -55°C and +110°C, referenced at +25°C, shall not exceed the values listed in Table III.

3.12 Shock. When resistors are tested as specified in 4.6.10, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the requirement in Table IV.

3.13 Vibration. When resistors are tested as specified in 4.6.11, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the requirement in Table IV.

3.14 Resistance to solvents. When resistors are tested as specified in 4.6.12, there shall be no evidence of mechanical damage, and the marking shall remain legible.

3.15 Terminal strength. When resistors are tested as specified in 4.6.13, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the requirement in Table IV.

3.16 Solderability. When resistors are tested as specified in 4.6.14, the criteria for wire-lead terminal evaluation, contained in the referenced test method, shall be met.

3.17 Radiographic. When resistors are tested as specified in 4.6.15, there shall be no evidence of manufacturing flaws such as improper positioning of elements, epoxy voids, presence of foreign materials, poor or open weld joints, end cap misalignment (see 3.3.4) or any other type of manufacturing defect that could affect life, serviceability, or performance.

3.18 Marking. Each resistor shall be marked with the Goddard part number, manufacturer's symbol, and date code. The date code shall be in accordance with MIL-STD-1285. Due to physical constraints, marking must be limited to three lines (8-character maximum). The following is an example of the complete marking:

9026VICO	-	Date code and manufacturer's symbol
G311P672	-	Goddard designator
1-1003F	-	Style, resistance value and tolerance

The date code shall be the date of the final assembly operation for the production lot, which for purposes of this specification, is the same as the inspection lot (4.5.2). The common manufacturing record shall include the same date code as that placed on parts covered by the record.

3.19 Workmanship. Resistors shall be processed in such a manner to be uniform in quality when inspected in accordance with 4.6.1. Resistors shall also be free of any defects affecting life, serviceability or performance.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. The manufacturer is responsible for the performance of all inspection requirements, as specified herein, using his own or any other suitable facility acceptable to Goddard Space Flight Center. Upon receipt of product, Goddard reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to verify conformance to prescribed requirements.

4.2 Classification of inspection. Inspection requirements specified herein are classified as follows:

a. Qualification Inspection (see 4.4)
b. Quality Conformance Inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.4 Qualification inspection (see 4.2). Qualification inspection shall be performed by the manufacturer on sample units produced with equipment, processes and procedures normally used in production.

4.4.1 Sample. The number of sample units comprising a sample of resistors submitted for qualification inspection shall be 75.

4.4.2 Sample selection. Sample units submitted for qualification shall consist of 15 high, 15 critical, and 15 low resistance values. The high and low values submitted will determine the range of resistance values qualified. Critical values permit testing at both full rated power and full rated voltage and are determined to be as follows:

Style 1 - 4 megohm
Style 2 - 8 megohm
Style 3 - 25 megohm

Qualification of resistors to a given tolerance also qualifies all higher tolerances.

4.4.3 Test routine. Sample units shall be subjected to the qualification inspection specified in Table V in the order shown. All sample units will be subjected to the inspections of Group 1. The samples shall then be subdivided as specified in Table V and subjected to the inspections of Groups 2 through 7.

4.4.4 Failures. Failures in excess of those allowed in Table V shall be cause for refusal to grant qualification.

4.4.5 Inspection report. Qualification test data and the qualification test samples shall be submitted to the following activity:

NASA/GSFC
Greenbelt, MD 20771
Attn: QPLD Administrator
Code 562

Table V. - Qualification inspection.

Inspection	Requirement Paragraph	Method Paragraph	Number of Sample Units	Number of Defects Allowed 1/
Group 1				
Visual and Mechanical	3.2.1, 3.3, 3.3.1, 3.18, 3.19	4.6.1	All Samples	0
DC Resistance	3.4	4.6.2		
Voltage Conditioning	3.9	4.6.7		
Group 2				
Solderability	3.16	4.6.14	12 Units	1
Resistance to Solvents	3.14	4.6.12	Any Value	
Group 3				
Thermal Shock	3.5	4.6.3		
Terminal Strength	3.15	4.6.13	15 2/	1
Radiographic	3.17	4.6.15		
Group 4				
Dielectric Withstanding Voltage	3.6	4.6.4		
Insulation Resistance	3.7	4.6.5	15 2/	
Overload	3.8	4.6.6		1
Thermal shock	3.5	4.6.3		
Group 5				
Full Load Stability	3.10	4.6.8	15 2/	1
Resistance Temp. Characteristic	3.11	4.6.9		
Group 6				
Shock	3.12	4.6.10	15 2/	1
Vibration	3.13	4.6.11		
Group 7				
Outgassing	3.2.2	4.6.16	3	0

1/ The aggregate total shall not exceed 2 defective units for the qualification samples.
2/ Sample selection of 5 high, 5 critical, and 5 low resistance values as specified in 4.4.2.

4.5 Quality conformance inspection (see 4.2). Quality Conformance Inspection (QCI) shall be performed on all product furnished to this specification.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of the QCI per Table VI in the order shown.

4.5.2 Inspection lot. An inspection lot shall consist of all resistor product of the same style, resistance value and tolerance, manufactured at essentially the same time under the same manufacturing process conditions and identified by a common date code (see 3.18).

4.5.3 Sample. The QCI shall be performed on 100% of the product furnished to this specification.

4.5.4 Failures. Resistors that no not pass the QCI shall be removed from the inspection lot and shall not be furnished to this specification.

4.5.5 Lot rejection. Only lots containing not more than 10% total workmanship and radiographic rejects and not more than 5% exceeding the final resistance change limit (ΔR) shall be furnished to this specification.

Table VI. - Quality conformance inspection.

Inspection	Requirement Paragraph	Method Paragraph	Criteria
Workmanship	3.19	4.6.1	As stated
DC Resistance	3.4	4.6.2	As stated
Thermal Shock	3.5	4.6.3	Except ΔR
Voltage Conditioning	3.9	4.6.7	Except ΔR
Terminal Strength	3.15	4.6.13	Except ΔR
DC Resistance	3.4	4.6.2	$\Delta R \pm 0.20\%$
Radiograph	3.17	4.6.15	As stated

4.5.6 Inspection record. The manufacturer shall be required to maintain a record of all QCI inspection results (see 4.5.7).

4.5.7 Retention of qualification. The manufacturer will be requested to furnish a summary of QCI inspection results annually as a basis for retention of qualification. The test summary shall be submitted to the activity specified in 4.4.5.

4.6 Methods of inspection.

4.6.1 Visual and mechanical inspection (see 3.2.1, 3.3, 3.3.1, 3.18 and 3.19). Resistors shall be examined to verify that materials, design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements.

4.6.2 DC resistance (see 3.4). Resistors shall be tested in accordance with Method 303 of MIL-STD-202. The applicable test voltage shall be 100 Vdc.

4.6.3 Thermal shock (see 3.5). Resistors shall be tested in accordance with Method 107 of MIL-STD-202 at Test Condition B, except the minimum test temperature shall be –55°C and the maximum test temperature shall be +110°C.

4.6.4 Dielectric withstanding voltage (see 3.6). Resistors shall be tested in accordance with Method 301 of MIL-STD-202. The applicable test voltage shall be 750 volts. The test voltage shall be applied between a conductive foil at circuit ground, that is wrapped around the resistor body, and the lead wires electrically shorted together.

4.6.5 Insulation resistance (see 3.7). Resistors shall be tested in accordance with Method 302 of MIL-STD-202 at Test Condition A or B.

4.6.6 Overload (see 3.8). Resistors shall be subjected to a load of 1.5 times the rated power (see 3.3.5) for 15 seconds. The maximum voltage shall be as specified in 3.3.6.

4.6.7 Voltage conditioning (see 3.9). Resistors may be mounted in any position in a chamber at a controlled test ambient temperature of 70°C (±2°C). The load applied shall be the maximum rated power (see 3.3.5) for a continuous duration of 100 hours minimum. The maximum voltage shall be as specified in 3.3.6.

4.6.8 Full load stability (see 3.10). Resistors may be mounted in any position in a chamber at a controlled test ambient temperature of 70°C (±2°C). The load applied shall be the maximum rated power (see 3.3.5) for a continuous duration of 1000 hours. The maximum voltage shall be as specified in 3.3.6.

4.6.9 Resistance temperature characteristic (see 3.11). Resistors shall be tested in accordance with Method 304 of MIL-STD-202 except the maximum temperature for the second series shall be limited to +110°C.

4.6.10 Shock (see 3.12). Resistors shall be tested in accordance with Method 213 of MIL-STD-202 at Test Condition I.

4.6.11 Vibration (see 3.13). Resistors shall be tested in accordance with Method 204 of MIL-STD-202 at Test Condition D.

4.6.12 Resistance to solvents (see 3.14). Resistors shall be tested in accordance with Method 215 of MIL-STD-202.

4.6.13 Terminal strength (see 3.15). Resistors shall be tested in accordance with Method 211 of MIL-STD-202 at Test Condition A. The applicable applied force shall be 2.5 pounds.

4.6.14 Solderability (see 3.16). Resistors shall be tested in accordance with Method 208 of MIL-STD-202.

4.6.15 Radiographic (see 3.17). Resistors shall be tested in accordance with Method 209 of MIL-STD-202. The following details shall apply:

a. Two views shall be exposed, perpendicular to the plane of the leads, with the second view made after rotation of the resistor 90° around its own axis.

b. A suitable image quality indicator (IQI) shall flank both sides of the resistor(s) under test. The IQI shall conform to the guidelines of ASTM E801.

c. Fine-grained film such as Kodak Type R or equivalent shall be used.

d. The radiographic process capability shall meet a minimum quality level of 2%-2T as defined in MIL-STD-453.

4.6.16 Thermal outgassing (see 3.2.2). Resistors shall be tested in accordance with ASTM E595.

5. PACKAGING

5.1 Packaging requirements. The preventive packaging requirements for electrostatic sensitive parts per MIL-R-39032 or the equivalent shall be followed.

6. NOTES

6.1 Ordering data. Acquisition documents should specify the following:

a. Number, title, and date of this specification.
b. Goddard Part Number
c. Quantity

6.2 Qualification provisions. With respect to product requiring qualification, awards will be made only for product which have been tested and approved by GSFC before the time for opening of bids. The attention of the suppliers is called to the following requirement: manufacturers should arrange to have qualification tests made on product which they propose to offer to GSFC to become eligible for awards of contracts or orders for product covered by this specification. The manufacturer shall bear the cost of qualification inspection to this specification. Information pertaining to qualification of product may be obtained from the activity whose address is listed in 4.4.5.

6.3 NOTICE. When GSFC drawings, specifications, or other data are sent for any purpose other than in connection with a definitely related GSFC procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever. The fact that GSFC might have formulated, furnished or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any person or corporation, or conveying any right or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodian:

Code 562
Goddard Space Flight Center
Greenbelt, MD 20771